

WHAT IS CLAIMED IS:

42. A method of producing biochips comprising the steps of:
arranging a plurality of capillaries having bottom open ends disposed at predetermined spacing so that said open ends are kept apart at all times from and adjacent to and above a planar substrate so that no current flows, said open ends having diameters which provide solution surface tension greater than gravitational force and prevent biomolecules from dropping down by force of gravity under non-depositing condition;

providing said biomolecules in said plurality of capillaries;
providing polymerase chain reaction to amplify said biomolecules within said plurality of capillaries;

applying a voltage across said plurality of capillaries and said substrate during a depositing condition so that the capillaries and substrate are oppositely charged to allow a very small volume of said biomolecules to move downward by force of attraction and swell out through said open ends at bottom of said capillaries and by force of attraction to deposit said biomolecules on sites on said substrate at space intervals coinciding with said predetermined spacings of said plurality of capillaries, wherein attractive forces between the solution and substrate occurs before contact; and

stopping applying said voltage during said non-depositing condition so that said biomolecules are held within said plurality of capillaries by surface tension at said open ends which is greater than said gravity; whereby

accurate efficient control of said voltage applying causes

uniform and reliable deposits of said biomolecules on said substrate.

43. The method of claim 42, wherein said polymerase chain reaction is performed by atmospheric temperature change or by heating with laser irradiation.

44. An apparatus for producing biochips comprising:
a plurality of capillaries having bottom open ends arranged at a same spacing interval as that of sites on a planar substrate disposed below said open ends of said plurality of capillaries and kept apart at all times so that no current flows, said open ends having diameters which provide solution surface tension greater than gravitational force and prevent biomolecules contained within said plurality of capillaries from falling down by force of gravity under normal non-depositing state;

amplifying means for providing polymerase chain reaction to amplify said biomolecules within said plurality of capillaries;

adjusting means for adjusting a gap formed between said open ends of said plurality of capillaries and said planar substrate by moving either said plurality of capillaries or said planar substrate, or both;

transfer means for transferring said biomolecules from said plurality of capillaries to said sites on said planar substrate during depositing state, and for enabling said biomolecules to remain in said plurality of capillaries during said non-depositing state, said transfer means comprising:

voltage means for applying voltage across said plurality of capillaries and said planar substrate so that the capillaries

and substrate are oppositely charged and the biomolecules contained in said plurality of capillaries and usually held therein by surface tension at said open ends are deposited in a very small volume by force of attraction and swelled out through said open ends and at bottom of said capillaries and by force of attraction onto said sites of said planar surface where attractive forces between the solution and the substrate occur before contact; and

stopping means for stopping applying voltage so that said surface tension of said open ends causes said biomolecules to be held within said plurality of capillaries during said non-depositing state against force of gravity;

whereby accurate control of said transfer means produces reliable and uniform biomolecule chips.

45. The apparatus of claim 44, wherein said amplifying means comprises means for providing said polymerase chain reaction by temperature processing.

46. The method of claim 42, wherein said biomolecules are swelled out from said open ends of said capillaries as droplets of picoliter size and deposited onto said substrate.

47. The apparatus of claim 44, wherein said voltage means comprises means for causing said biomolecules to be swelled out from said open ends of said capillaries as droplets of picoliter size and deposited onto said substrate.